Synthesis of Optimal Nonlinear Feedback Laws for Dynamic Systems Using Neural Networks

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## SUMMARY

Open-loop solutions of dynamical optimization problems can be numerically computed using existing software packages. The computed time histories of the state and control variables, for multiple sets of end conditions can then be used to train a neural network to "recognize" the optimal, nonlinear feedback relation between the states and controls of the system. The "learned" network can then be used to output an approximate optimal control given a full set (or a partial set) of measured system states. With simple neural networks, we have successfully demonstrated the efficacy of the proposed approach using a minimum-time orbit injection problem. The usefulness and limitations of this novel approach on real-life optimal guidance and control problems, with many state and control variables as well as path inequality constraints, remain to be seen. However, if in fact the proposed methodology is found to scale up well to realistic problems, it would have significant potential in generating optimal feedback laws for a variety of guidance and control problems.

**Keywords.** Neural networks, Nonlinear feedback laws, Optimal guidance and control problems, Orbit injection problem.